Appendix T. Comparison of Events with Relevant Transocean Well Control Policies, Practices and Procedures

This appendix sets forth excerpts from BP's drilling services contract with Transocean[1] (referred to as "the Contract") and the *Transocean Well Control Handbook*[2] (*TWCH*). These documents governed the drilling operations on board *Deepwater Horizon* at the time of the accident.

Under the terms of the Contract (Article 15.1), Transocean is:

> *. . . solely responsible for the operations of the Drilling Unit, including without limitation, supervising moving operations, and the positioning of the Drilling Unit on drilling locations as required by [BP], as well as such operations on board the Drilling Unit as may be necessary or desirable for the safety of the drilling unit.*

Article 15.2 of the Contract further provides that Transocean:

> *. . . shall maintain well control equipment in accordance with good oilfield practices at all times and shall use all reasonable means to control and prevent fire and blowouts and to protect the hole and all other property of [BP].*

Article 18.1 of the Contract affirms that Transocean is an "independent contractor," although BP retains right of inspection and approval of the work performed on its behalf, and states that BP:

> *. . . shall have no direction or control over [Transocean] or its employees and agents except in the results to be obtained. The actual performance and superintendence of all work hereunder shall be by [Transocean] . . .*

The investigation team reviewed the *TWCH* to identify relevant practices, procedures and expectations, and compared them with the rig crew's actions in monitoring the Macondo well and managing the well control event on April 20, 2010.

---

[1] *Contract No. 980249, Drilling Contract RBS-8D, Semisubmersible Drilling Unit, Vastar Resources, Inc. and R&B Falcon Drilling Co. dated December 9, 1998, as amended.*

[2] *Manual Number HQS-HB-01, Issue Number 03, Revision Number 01, Revision Date March 31, 2009.*

The analysis in this appendix is based upon:

- Excerpts from the *TWCH*.
- Real-time Sperry-Sun data.
- Witness account interview notes of non-Transocean personnel.
- Marine Board of Investigation (MBI) testimony.

Table 1. *TWCH* Well Control Procedures and Responsibilities.

Introduction				
Section	**Sub-section**	**Ref.**	**Title**	**TWCH Excerpt**
1	1	2	Well Control Policies & Procedures	On all Transocean Installations, it is the responsibility of the OIM to assure the implementation of the well control policies and procedures contained within the Company's management system. Company personnel with well control responsibilities must understand and comply with the Company-approved well control policies and procedures. Prevention and management of well control incidents must conform to the requirements detailed in the Well Control Manual and be carried out by competent, well control certified personnel.
1	1	2	Well Control Policies & Procedures	Procedures represent mandatory requirements to meet policies. Procedures are represented by statements that include the term "must" "will" or "shall."
Well Control Procedures				
1	2	1.1	Preparation Procedures	Prior to spudding, it is the responsibility of the Rig Manager Performance, in conjunction with the OIM, to review the well program and ensure that well control issues have been addressed. This would include potential blowout/underground blowout situations and contingency plans. No well will be spudded or hole section started unless the Rig Manager Performance and OIM have reviewed the relevant information.
1	2	2.1	Prevention Procedures	▪ If there is any indication of flow, consider shutting in the well immediately rather than taking the additional time to conduct a flow check. ▪ Establish a baseline reading and continually monitor for any variation in trends for gas, mud, cuttings and drilling parameters. Toolpusher and client personnel should be in constant communication with the mud logging unit and the well site geologist (where available). ▪ Whenever possible, limit circulation to a single active pit. Strictly enforce pit management, and carefully monitor for any discrepancies during trips.

The investigation team has not identified evidence that the review described in *1.1 Preparation Procedures* in *Table 1* occurred.

Regarding *2.1 Prevention Procedures* in *Table 1*: On April 20, 2010, from 13:28 hours to 17:17 hours, mud was transferred to the supply vessel, M/V *Damon Bankston*. Witness accounts indicated that transfering mud from the pits to the boat impaired the ability of the mudloggers to reliably monitor pit levels. In an interview with the investigation team, a mudlogger stated that this concern was raised with the assistant driller. The response was reportedly that the assistant driller would notify the mudlogger when the mud transfer was complete and monitoring could resume. The mudlogger also indicated that this notification did not occur after mud transfer to the supply vessel stopped at 17:17 hours. The investigation team concluded that the mudloggers did not effectively monitor pit volumes for the remainder of that day.

Table 2. *TWCH* Well Control Procedures and Responsibilities—Prevention.

Well Control Procedures				
Section	**Sub-section**	**Ref.**	**Title**	**TWCH Excerpt**
1	1	2.5	Prevention Procedures	When there is no open hole exposed the manager must be satisfied that the integrity of the barriers involved, such as mechanical or cement plugs, or cemented liners and casing strings have been suitably tested. ▪ In the case of an exploration well, sufficient data must have been collected to meet all of the above requirements. Even then, extreme caution should be exercised. ▪ Pit and flow line instrumentation settings must be sensitive enough to detect an influx while lined up to an active pit instead of the trip tank.

The *TWCH* did not clearly define who 'the manager' was, nor could the investigation team verify whether anyone who may have fit that description made any inquiries about the results of the negative-pressure test at the time the negative-pressure test was concluded.

The investigation team considers that "extreme caution" in this context could include factors such as pressure changes and flow increases. “Extreme caution” would also include isolating individual pits to facilitate volume monitoring when transferring mud to the supply vessel.

As previously stated, the evidence indicates that the mudlogger’s equipment was not being used effectively to monitor fluid volumes. It is unknown what equipment the driller or assistant driller was using to monitor the well. However, pressure and flow variations should have been available that would have indicated an abnormality with the well.

Table 3. *TWCH* Well Control Procedures and Responsibilities—Detection.

Well Control Procedures				
Section	**Sub-section**	**Ref.**	**Title**	**TWCH Excerpt**
1	1	3.1	Detection Procedures	It is the responsibility of the Driller (or the person performing the Driller's role) to shut-in the well as quickly as possible if a kick is indicated or suspected.
Well Control Responsibilities				
Section	**Sub-section**	**Ref.**	**Title**	**TWCH Excerpt**
1	3	4	Offshore Installation Manager (OIM)	The OIM is responsible for overall safety of the installation and all the personnel onboard.
1	3	6	Driller (D)	The Driller is responsible for monitoring the well at all times, identifying when the well is to be shut-in and shutting-in the well quickly and safely.

Table 4. *TWCH* Well Control Principles—Kicks.

Secondary Well Control				
Section	**Sub-section**	**Ref.**	**Title**	**TWCH Excerpt**
3	2	2	Kick Size and Severity	Minimizing kick size is fundamental in enhancing the safety of a well control operation.

As described in the *Table 3* and *Table 4* excerpts, it is the driller's responsibility to detect and shut in the well quickly in the event of a well control situation. It appears to the investigation team that the driller and the toolpusher did not realize that there was an impending well control event. The information available indicates that the pumps were stopped, but the driller and toolpusher apparently were trying to understand the 'differential pressure' just prior to the accident. (Refer to chief mate's MBI hearing testimony on the following page.)

Real-time data shows that the mud pumps were shut down at 21:31 hours on April 20, 2010.

Notes from an interview with the Weatherford rig assistant specialist indicated:

> Around 21:00 to 21:30 [the toolpusher] was called to go to rig floor.

The Transocean chief mate stated during the MBI hearing on May 27, 2010:

> "[At 21:30 hours] I was on the drill floor to talk with the toolpusher and driller to find out about the time for the cement job. They had a concern with differential pressure."

Table 5. *TWCH* Well Control Principles—Blowout.

Tertiary Well Conditions				
Section	**Sub-section**	**Ref.**	**Title**	**TWCH Excerpt**
3	3	3	Blowout/ Underground Blowout	It is critical to establish, prior to drilling any hydrocarbon bearing formations, that potential blowout/underground blowout situations have been addressed. This must be covered in the Emergency Response Procedures developed jointly by the Company and the Operator.

The investigation team requested the *Emergency Response Procedures* document that is referenced in *Table 5*. However, at the time this report was written it had not been received.

Table 6. *TWCH* Preparation and Prevention.

Preparation of Equipment and Materials				
Section	**Sub-section**	**Ref.**	**Title**	**TWCH Excerpt**
4	1	3.3	Return Flow Measurement	The flow line must be equipped with a device for measuring the rate of return flow from the well. A gauge/readout complete with an adjustable, audio-visual alarm must be installed on the Driller’s instrument panel.

Real-time data indicates an increase in return flow from the well at 20:58 hours on April 20, 2010, approximately 51 minutes before the first explosion. Transocean's *Deepwater Horizon* investigation interim report states, and real-time data indicates, that the trip tank was being emptied at that time. This may have masked the volume change caused by flow from the well. However, drill pipe pressure also increased and went unnoticed. The real-time data indicates that a 39 bbl gain was taken in the mud pits at that time.

At 21:08 hours on April 20, 2010, pumping was stopped, and a sheen test was performed on the spacer returning from the well. From this time forward, the fluid returning from the well was discharged overboard. If the driller’s flow meter had been operating properly, increasing return flow would have been detectable at this time.

While fluids were being discharged overboard, the mudloggers’ flow meter was bypassed; therefore, the mudloggers were unable to monitor flow.

Notes from an interview with a mudlogger indicate:

> [The] sensor [used] to measure flow out is about 15 ft. downstream of the flow line valve. You wouldn't see flow if the diverter was activated or going through the dump line. The measurement for the rig floor has a paddle, and the mud logging system is far more accurate.

Table 7. *TWCH* Actions upon Taking a Kick.

Containment As Early As Possible				
Section	**Sub-section**	**Ref.**	**Title**	**TWCH Excerpt**
5	2	1	Containment As Early As Possible	When a well kicks, it should be shut-in within the shortest possible time. . . . It is the Driller's (or the person performing the Driller's function) responsibility to shut-in the well as quickly as possible if a kick is detected or suspected using the procedure in Section 5 Subsection 3.

The summarized sequence (from the *TWCH*) for shutting in a well when either tripping or drilling is to:

- Close the annular preventer (upper preferred), and open the choke line valves on the blowout preventer (BOP) stack.
- Notify the toolpusher and OIM (who must then notify the operator representative).
- Monitor the riser for flow once the BOP is closed.

OLGA® well flow modeling indicates that between 21:36 hours and 21:38 hours a valve was opened and closed on the rig floor, presumably to bleed off pressure from the drill pipe. Based on witness accounts, the investigation team concluded that this occurred approximately 4 minutes before mud started flowing onto the rig floor.

Real-time data indicates that circulation continued after flow increased and pump pressures fluctuated between 20:58 hours and 21:31 hours. By the time the mud pumps were shut down at 21:31 hours, an estimated 300 bbl gain had been taken into the wellbore, and the well was flowing.

These events do not support a conclusion that actions were taken to shut in the well in the shortest possible time, as required by the excerpt in *Table 7*.

Table 8. *TWCH* Deepwater Environments.

Deepwater				
Section	**Sub-section**	**Ref.**	**Title**	**TWCH Excerpt**
8	4	8.1	Kick Prevention	The standard kick prevention methods apply in deepwater as in shallow water.
8	4	8.2.1	Surface Detection	The same warning signs, pit gain and increased return flow, apply in deepwater wells.
8	4	9	Handling Gas in the Riser	When a kick is taken while drilling with a marine riser (particularly in deepwater) there is a possibility that the gas will have migrated or been circulated above the BOP stack before the well is shut-in. If this occurs, the choke manifold and the MGS may no longer be able to control the flow rates when the riser gas reaches surface.
8	4	9.1	Volumes and Flow Rates	Large volumes of gas above the BOP stack can rise rapidly and carry a large volume of mud out of the riser at high rates. The key to managing gas in a riser is to avoid situations where large volumes of gas get above the BOP stack.
8	4	9.2	Equipment for Handling Gas in the Riser	The diverter system above the telescopic joint with two (2) overboard lines and a system to remove gas from large volumes of mud and return it to the mud system (such as a mud box and the overboard line) is preferred. The diverter and overboard lines should be designed to handle high flow rates and be as straight as possible. This system is not designed to choke or control high gas or liquid flow; rather, it is a system to keep combustible gases safely away from sources of ignition and to remove gas from the mud. At any time, if there is a rapid expansion of gas in the riser, the diverter must be closed (if not already) and the flow diverted overboard.
8	4	9.3	Procedure for Handling Gas in the Riser	These procedures are to be conducted along with the shut-in procedures for Subsea BOPs as described in Section 5. ▪ Limit the volume of gas that may be taken above the BOP stack (early detection). ▪ If an influx is suspected, shut off the mud pumps. This will help avoid circulating the gas above the BOP stack. ▪ Shut in the well as quickly as possible. ▪ Conduct a riser flow check. If the riser is flowing, divert the flow overboard. If so equipped, the flow can be diverted through a gas handling system or MGS. ▪ If the riser is not flowing or has stopped flowing, continue to monitor it for flow. Do not leave it unattended. ▪ If so equipped and if the MGS is not being used for the primary well control operations, the riser fluid may be circulated through the MGS at slow rates to remove gas from the fluid. ▪ Circulate the riser at slow rates. Stop circulation and conduct a riser flow check after every 100 bbls pumped or equivalent volume to +- 250 ft of riser. ▪ If gas is seen at surface, stop pumping and watch for flow. Allow the flow to deplete before continuing. ▪ If the flow rate increases, be prepared to open the diverter line and send the mud overboard.

Notes from an interview with the Weatherford rig assistant specialist indicate:

> Minutes after that [I] noticed mud shoot up the side of the drill pipe. Went midway up the derrick, came down a little bit, then went past the derrick.

The Transocean crane operator stated during the MBI hearing on May 29, 2010:

> . . . and that's when I seen mud shooting all the way up to the derrick. After I saw the mud shooting up, just several seconds, and then it just quit and went down …. several seconds after that . . . And then all of a sudden the degasser mud started coming out of the degasser . . . It's on the starboard aft of the derrick, and it's in a gooseneck, and it points back down to the deck. And it comes out of it so strong and so loud, that it just filled up the whole back deck with gassy smoke, and it was loud enough that it was like taking an air hose and sticking it up to your ear. And then something exploded. I'm not sure what it was that exploded, but just looking at it, where the degasser is sitting, there's a big tank and it goes into a pipe [MGS]. I'm thinking that the tank exploded.

In this instance, witness accounts confirm that the flow volume through the rotary table at surface was significant. Based on the procedure defined in *9.2 Equipment for Handling Gas in the Riser* in *Table 8*, the mud flow should have been routed overboard. Instead, the mud flow was routed through the mud gas separator (MGS). Based on gas dispersion and explosion analysis, the investigation team concluded that if the rig crew had diverted to the overboard discharge line rather than to the MGS, the consequences of the event would likely have been reduced.

The mudlogger's well monitoring equipment was installed and working, but it was apparently not being used due to the mud transfer to the supply vessel and mud pit cleaning activities. There is no evidence to suggest that either the driller or assistant driller was monitoring the well fluid volumes and flows. A more timely response to well conditions may have occurred if "constant, accurate observation and recording of the mud volume" had taken place as defined in *4.5 HPHT Drilling Guidelines* in *Table 9*.

In the opinion of the investigation team, despite the guidance provided in the TWCH, wellbore monitoring did not identify the influx until after hydrocarbons were in the riser, and the subsequent action taken prior to the explosion suggests the rig crew was not sufficiently prepared to manage an escalating well control situation.

Table 9. *TWCH* HPHT Environments.

High Pressure High Temperature (HPHT)				
Section	**Sub-section**	**Ref.**	**Title**	**TWCH Excerpt**
8	5	4.3	Kick Detection	All efforts must be made to ensure that pit level indicators and flow sensors are properly installed and calibrated. NOTE: Recognizing the signs of an influx and acting with the necessary speed to minimise it requires constant, accurate observation and recording of the mud volume, weight and relative parameters. The resulting trends give the best picture of the well situation. Any variance can be identified, investigated and resolved before the situation deteriorates. The crucial feature is the "communications triangle" between the Driller, Mud Loggers and Derrickman/Mud Engineer in the mud pits. It is essential that all information is regularly shared between the three points that relevant personnel develop a good understanding of the current well condition. The Derrickman measures the pit volumes and records them, the Driller records the active volume of his drilling trend sheet along with any variation from the previous reading. The mud logging system is also constantly observed, therefore any variation from the established trend can be quickly investigated. The Driller has full authority to flow check or shut in the well as he sees fit and is expected to fully investigate any occurrence which deviates from a stable trend.
8	5	4.5	HPHT Drilling Guidelines	All drilling operations shall be conducted in such a manner that the possibility of an influx is minimized. Essential monitoring techniques and instrumentation will be available to rig site personnel. These personnel will be trained and practiced in the collection and interpretation of essential data related to kick prevention and detection. Furthermore, essential personnel will be instructed in the importance of data collection instrumentation and the need for its proper care and maintenance.